Derivation of DRBC Human Health Stream Quality Objectives
Revised November 9, 2009

The DRBC proposed human health criteria have been developed in accordance with the Methodology for Ambient Water Quality Criteria for the Protection of Human Health (2000) (EPA-822-B-00-004, October 2000). Listed below are equations used for deriving human health criteria for carcinogens and non-carcinogens.

Noncancer effects

$$AWQC = Rfd * RSC * \left(\frac{BW}{DI + \sum_{i=2}^{4} FIi * BAFi} \right)$$

Cancer effects: nonlinear low-dose extrapolation

$$AWQC = \frac{POD}{UF} * RSC * \left(\frac{BW}{DI + \sum_{i=2}^{4} FIi * BAFi} \right)$$

Cancer effects: linear low-dose extrapolation

$$AWQC = RSD * \left(\frac{BW}{DI + \sum_{i=2}^{4} FIi * BAFi} \right)$$

AWQC (mg/L)
Rfd = reference dose for noncancer effects (mg/Kg-day) from IRIS
POD = Point of departure for carcinogens based on a nonlinear low-dose extrapolation (mg/kg-day, usually LOAEL, NOAEL, or LED_{10} from IRIS
UF = uncertainty factor for carcinogens based on a linear low-dose extrapolation (unitless)
RSD = risk-specific dose for carcinogens based on a linear low-dose extrapolation (mg/kg-day) (dose associated with a target risk, such as 10^{-6})
RSC = relative source contribution factor to account for non-water sources of exposure (not used for linear carcinogens) May be either a percentage (multiplied) or amount subtracted, depending on whether multiple criteria are relevant to the chemical.
BW = human body weight (default = 70 kg for adults)
DI = drinking water intake (default = 2L/day for adults)
FIi = fish intake at trophic level (TL) I (I= 2, 3 and 4) (defaults for total intake = 0.0175 kg/day for general adult population and sport anglers, and 0.1424 kg/day for subsistence fishers). Trophic level breakouts for the general adult population and sport anglers are: TL2=0.0038 kg/day; TL3 = 0.0080 kg/day; and TL4= 0.0057 kg/day.
BAFi = bioaccumulation factor at trophic level I (I = 2, 3 and 4), lipid normalized (L/kg) (EPA 2003 updates used BCF)

Reference Dose (RfD): An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in EPA's noncancer health assessments. [Durations include acute, short-term, subchronic, and chronic and are defined individually in this glossary]. Formerly called **Acceptable Daily Intake (ADI)**:

Point of Departure: The dose-response point that marks the beginning of a low-dose extrapolation. This point can be the lower bound on dose for an estimated incidence or a change in response level from a dose-response model (BMD), or a NOAEL or LOAEL for an observed incidence, or change in level of response.

The U.S. Environmental Protection Agency's Guidelines for Cancer Risk Assessment (USEPA, 2005) present the default approach for the cancer slope factor as the slope of the linear extrapolation to the origin, generally drawn from the 95% lower confidence limit on dose at the lowest prescribed risk level supported by the data. In the past, the cancer slope factor has been calculated as the upper 95% confidence limit on the coefficient (q*1 cancer potency factor) of the linear term of the multistage model for the extra cancer risk over background.

Notable among the DRBC criteria revisions is the use of 17.5 g/day of fish intake for deriving criteria in all Zones of the Delaware River. Therefore, separate freshwater and marine criteria are not proposed. Human health criteria for consumption of water and organism and human health criteria for consumption of organism only are proposed based on the USEPA national recommended water quality criteria and updated human health standards in basin states.

It is the policy of the Commission to designate numerical stream quality objectives for the protection of human health for the Delaware River Estuary (Zones 1 through 6) which correspond to the designated uses of each zone. Stream quality objectives for protection from both carcinogenic and systemic effects are herein established on a pollutant-specific basis for pollutants listed as toxic under Section 307(a)(1) of the Clean Water Act , other toxic pollutants, and other chemicals for which EPA has published final criteria under Section 304(a) of the Act. Other toxic substances for which any of the Basin states have adopted criteria or standards may also be considered for the development of stream quality objectives. Also considered in derivation of stream quality objectives are the following:

1. An objective to protect against carcinogenic effects shall only be established if the pollutant is classified A, B or C under the U.S. EPA classification system for carcinogens, and if a cancer potency factor (CPF) exists in IRIS. (Table 1)

2. An objective to protect against systemic effects shall only be established for a pollutant if a reference dose (RfD) exists in IRIS. An additional safety factor of 10 shall be utilized in establishing the stream quality objectives to protect against systemic effects for pollutants classified as carcinogens if a CPF is not available in IRIS. (Table 2)

3. In the absence of toxicological data for an RfD or CPF in IRIS, data published in the 1980 U.S. EPA water quality criteria documents and New Jersey Drinking Water Quality Institute (NJDWQI) historical documents will be considered.

4. In establishing stream quality objectives for carcinogens, the level of risk is established at 10^{-6} or one additional cancer in every 1,000,000 humans exposed for a lifetime (70 years).

5. For the purpose of determining compliance with human health stream quality objectives, the duration of exposure shall be 70 years for carcinogens and 30 days for systemic toxicants.

6. A rate of ingestion of water of 2.0 liters per day is assumed in calculating objectives for river zones where the designated uses include public water supplies after reasonable treatment. A rate of ingestion of fish of 17.5 grams per day (equivalent to consuming a ½ pound portion every 35 days) is assumed in calculating stream quality objectives for human health in all zones.

In addition, certain criteria were derived based on methods approved by the EPA and adopted by one or more within basin state by:

1) using relative potency factors (i.e., benzo(a)pyrene (1.0), benz(a)anthracene (0.1), benzo(b)fluoranthene (0.1), benzo(k)fluoranthene (0,01), chrysene, (0.001), dibenz(a,h)anthracene (1.0), and indeno (1,2,3-c,d)pyrene (0.1))(Tables 1 and 2);
2) following Group C carcinogens policy by using a carcinogenic slope factor at a 10^{-6} excess cancer risk level or if such a slope factor is not available, the risk assessment will then be based on non-carcinogenic effects using a reference dose with an additional uncertainty factor of ten to protect from possible carcinogenic effects (e.g., beryllium and butylbenzyl phthalate) (Table 1);
3) including relative source contribution (RSC) in the proposed criteria when RSC are included in finalized EPA criteria or standards adopted by basin states (e.g., endrin) (Table 2);
4) Using data for a compound to derive a criterion for a compound with similar toxicology (i.e., 1, 3 – dichlorobenzene and 1, 4-dichlorobenzene using data for 1,2-dichlorbenzene; bromoform using data from chloroform) (Tables 1 and 2)

Tables

Table 1: Toxicological Data and Calculations for DRBC Human Health Water Quality Criteria For Carcinogens

Table 2: Toxicological Data and Calculations for DRBC Human Health Water Quality Criteria Systemic Toxicants

Comparison of Within Basin Criteria

A supplemental comparison of within basin criteria shows differences in criteria among basin states. The criteria comparison illustrates the advantages of a set of uniform criteria for the mainstem waters and the need to update existing DRBC criteria using consistent methodologies and current scientific information. (Tables 3 and 4)

Tables

Table 3: Ambient Water Quality Criteria Comparison for the Delaware River: USEPA, Delaware, New Jersey, New York, Pennsylvania, and DRBC - Humans Health For Consumption of Water and Organism

Table 4 Ambient Water Quality Criteria Comparison for the Delaware River: USEPA, Delaware, New Jersey, New York, Pennsylvania, and DRBC - Humans Health For Consumption of Organism Only